

Science and Technology Pre-Service Teachers' Tendencies to Explain Vitality

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Abstract

The present study was carried out to determine the Science and Technology pre-service teachers' tendencies to explain vitality in a university located in Southeast Anatolia of Turkey in 2010-2011 academic year. The data were collected through the administration of a questionnaire developed by the researcher to 1st and 4th year Science and Technology pre-service teachers (N=123). At the end of the study, it was found that Science and Technology pre-service teachers have a tendency to explain vitality through anthropomorphic references such as "vitalist", "animist", "teleologic" types besides biological facts. In the light of these findings, suggestions to teach the biological nature of vitality in a proper manner were made.

Key Words

Vitality, Causality, Antropomorphic Terminology, Biology Education.

In the development of scientific thinking and in the comprehension of natural phenomena with this thinking, the important place assumed by language and terminology starting from childhood (Piaget, 2002; Vygotsky, 1998) shows the importance of language and terminology practices in science education (Lena & Quere; 2011, p. 11). Hence, determination of the language and terminology students draw on to explain the phenomenon of vitality, which is one of the most critical subject of biology, will make a great contribution to the understanding of which thoughts and beliefs affect students' comprehension of natural phenomena.

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In its simplest form, science is an understanding and explanation of natural phenomena based on their causes (Marshall & Zohar, 2003, p. 268). Therefore, explanation in science means linking an event to its causes and derives a result from these causes, particularly in science of physics (Reichenbach, 2000, p. 124). For a long time, under the influence of mechanistic thinkers such as Descartes and Bacon, biological phenomena were explained by means of physical laws (Mayr, 2008, p. 9). However, as a result of advancing science of biology, it was realized that biological processes cannot be thoroughly explained through physical laws and terminology restricted to these laws (Sober, 2009, p. 70). In the leadership of Mayr (2008), it was proved that "why" question concerning the behavior of a living entity can be explained through biology-specific causality approach that is described as proximate and ultimate.

On the other hand, pre-science alternative thinking and belief styles of anthropomorphic type considering humanitarian and divine references in the explanation of natural phenomena still maintain their influences to a great extent, particularly in

science of biology (Keton, Gould, & Gould, 1999; Örs, 2010; Tura, 2011; Zohar & Ginossar, 1998). In this respect, in the explanation of biological phenomena such as "flower's turning to sun to get more light" and "bees' liking colorful flowers", anthropomorphic thinking styles such as "vitalist", "animist", "teleologic" etc. are frequently employed (MEB, 2005). Particularly, in the explanation of biological events, not much is used apart from the teleologic statements based on purpose (target)-oriented thinking (Ayala, 1970; Dawkins, 2006; Gali & Meinardi, 2011; Kelemen, 2004). In this regard, when the intentional human deeds such as "making a knife sharp", "production of a car" are considered, "artificial" teleology is employed and when natural phenomena are considered, "natural" teleology emphasizing divine will is employed (Ayala, 1970; Gali & Meinardi; Piaget, 2002; Ros, 1982). However, teleologic thinking employed while explaining human activities creates an important barrier in front of the comprehension of natural system and development of scientific thinking (Rosenberg & McShea, 2008).

It is stated that in the scientific comprehension of biological phenomena, particularly evolutional processes, non-scientific alternative thinking styles such as animist, vitalist and teleologic etc. are frequently used and this makes it difficult for students to scientifically explain natural events (Anderson, Fisher, & Norman, 2002; Bishop & Adnerson, 1990; Deadman & Kelley, 1978; Gali & Meinardi, 2011; Jungwirth, 1979; Kelemen, 1999, 2003; Tamir, 1985; Zohar & Ginossar, 1998). On the other hand, this type of anthropomorphic explanations are claimed to facilitate for students to permanently and meaningfully learn vitality-related phenomena (Öztaş, Yel, & Öztaş, 2005; Zohar & Ginossar). Therefore, for the proper use of anthropomorphic language and terminology such as animist, vitalist, teleologic etc in teaching of biological events, investigation of the place of this language and terminology in the explanation of the issue of vitality which is the central issue of biology teaching is of great importance.

Purpose

There is no other study except for Özdemir (2010) and Yörek (2007) carried out on this research topic in Turkey; therefore, there is a need to reveal the extent to which biological phenomena, primarily the phenomenon of vitality, are explained in line with the nature of biology. Hence, the present study tries to determine how Science and Technology

pre-service teachers explain vitality based on their responses to explanations for various vitality states. For this purpose, answers to following questions were sought:

- 1) What are the physical causal explanations of Science and Technology pre-service teachers related to vitality?
- 2) What are the biological causal explanations of Science and Technology pre-service teachers related to vitality?
- 3) What are the alternative (non-scientific) explanations of Science and Technology pre-service teachers related to vitality?
- 4) Does grade level have any effects on Science and Technology pre-service teachers' explanation of vitality?

Method

The presents study employs survey model.

Participants

The present study was carried out on 1st year and 4th year Science and Technology pre-service teachers (n=123) in 2010-2011 academic year. All the 1st year Science and Technology pre-service teachers (53.7%) and 4th year Science and Technology pre-service teachers (46.3%) of the faculty participated in the study. The sampling was made up by 1st and 4th year students as 1st year students did not take any biology course yet and 4th year students already took all the biology courses.

Data Collection

Data of the study were collected through the administration of a questionnaire developed by the researcher as a result of a literature review (Mayr, 1961; Ros, 1982). The questionnaire consists of statements corresponding to the explanations made from physicalist, biologic and anthropomorphic/teleologic perspectives. Here students are asked to indicate their opinion by marking one of the options which are "Agree", "Disagree", "No idea" and then write the reason for the choice. The questionnaire consists of two parts. In the first part (A), examples of "physicalist" and "biologic" explanations are given respectively, and then statements corresponding to various types of a biologic explanation are sequenced. The statements in the first parts are organized as "physicalist-A1, "selec-

tive causal"-A2, "vitalist"-A3, "biologic"-A4 and "teleologic"-A5 explanations, respectively. The second part (B) consists of concrete statements related to the behavior of nightingale emphasized by Mayr (1961). These correspond respectively to explanation types described as "proximate (ecologic) causal"-B1, "proximate (internal) causal"-B2, "proximate (external) causal"-B3, "ultimate (evolutionary) causal"-B4, "teleologic"-B5 and "teleonomic"-B6 (App-1: Questionnaire). In line with the conceptual basis of the study, "A2", "A4", "B1", "B2", "B4" and "B6" statements are described as positive and "A1", "A3", "A5" and "B3" and "B5" are described as negative. And, approval of the positive statements and disapproval of negative statements are interpreted as an indication that proper explanations for vitality can be made.

Construct validity of the questionnaire items was established by seeking the opinions of three experts from three different disciplines (physic education, philosophy of biology and psychology). In addition to this, Cronbach Alpha value was calculated to be "0.860"; hence, it was concluded that the questionnaire is reliable. Draft questionnaire was administered to a group having similar characteristics with the participants of the present study for piloting purpose and by analyzing the responses of the piloting group to the questionnaire items, the understandability of the items was checked. Then, required corrections were made and final form of the questionnaire was given.

Data Analysis

At the end of the study, the collected data were transferred into SPSS program package. For this purpose, the options "Agree", "Disagree" and "No idea" given for positive statements (A2, A4, "B1", B2, B4, "B6") are coded into numbers as "2", "1" and "0", respectively, and the same options given for negative statements (A1, A3, A5, B3, B5) are coded into numbers as "1", "2" and "0". In this way, it became possible to calculate frequencies and percentages for approval or disapproval of each statement. Based on the calculated frequencies and percentages, the weights of students' tendency to explain vitality were determined. In order to determine the impact of education taken by the students on their tendencies to explain vitality, percentages for approval obtained separately by 1st year students and 4th year students were compared through Chi square test and then tabulated.

Moreover, in order to analyze the students' tendencies to explain vitality more deeply, the students were asked to give written explanations about their choices made for questionnaire items. The written responses of the students were analyzed through content analysis. For this, first the written responses of the students were scanned to prepare a "coding key" (App-3: Coding Key). The written responses of students for each statement were analyzed according to the coding key and coded into different categories from broader to narrower as "category", "theme" and "sub-theme". As a result, it was concluded that the students' tendencies to explain vitality are subsumed under two categories as "mechanist" and "non-mechanist" and related themes and sub-themes within these categories. While mechanist category is represented by "physicalist" explanation, non-mechanist category consists of different themes described as "selective causal", "biologic" and "vitalist" and teleologic". The data were interpreted by being exemplified with students' original expressions.

Findings

In the present study, the Science and Technology pre-service teachers' tendencies to explain vitality were elicited through their responses to some statements related to vitality and to the explanations given for a specific state of vitality (immigration of nightingale). At the end of the study, it was found that although the fact that physical rules are valid in the universe is accepted, there is an awareness of the fact that other elements different from physical laws may be influential on vitality. High majority of the participants admit that vitality can be explained according to comprehensible and observable biologic factors. Considerable ratio of the students prefers to explain vitality through metaphysical references such as animist, vitalist, teleologic. This shows that for the explanation of vitality, besides biological facts, anthropomorphic/teleologic thinking is also frequently capitalized on. This finding concurs with that of Jungwirth (1979) and Kelenmen (2003) pointing out the prevalence of anthropomorphic/teleologic thinking in understanding biologic phenomena. On the other hand, as a result of the content analysis of the participants' opinions about each state of vitality, it was found that those approving and rejecting explanations conceptualized as "physicalist", "selective causal", "vitalist", "biologic" and "teleologic" submit consistent facts under the influence of primarily "mechanist" and "non-mechanist" references. This indicates that

the participants refer to alternative means such as anthropofromic/teleologic besides scientific data while explaining vitality. Adoption of scientific and non-scientific approach to the nature of vitality by the Science and Technology pre-service teachers supports the claim proposed by Tura (2011) arguing that animist and supernatural thinking motives still maintain their influence on humans' design of nature. In a similar manner, Deadman and Kelley (1978) and Gali and Meinardi (2011) point out that students perceive evolutionary processes according to teleological thinking. Adoption of explanations made at proximate and ultimate levels by the participants related to the immigration behavior of the nightingale indicates that they can explain the behavior of a living thing from ecologic and evolutionary perspectives. Almost all of the participants think that immigration movement of the nightingale is an instinctive response to the changing environmental conditions. This shows that the participants can make reasonable explanations for the behaviors of living things at proximate and ultimate levels in compliance with the nature of biology. However, they offered vitalist and teleologic explanations for the same state of vitality and this can be interpreted as their still being under the influence of non-scientific thoughts to some extent. In this respect, almost all of the participants emphasize that there is a purpose and intention followed to stay alive behind the immigration behavior of the nightingale. This clearly shows that biologic phenomena are conceived in terms of anthropoformic thinking such as vitalist and teleologic. On the other hand, no significant difference was found between the 1st year students' tendency to explain the vitality and that of the 4th year students, this shows that four year Science and Technology education does not result in much change in students' explanation of vitality. This is mostly because in teaching of biology subjects, anthropomorphic terminology of vitalist, animist, teleologic type is frequently employed.

Discussion

In science education, highlighting the effects of non-scientific anthropoformic thinking and terminology such as animist, vitalist, teleologic etc. on the teaching of biological subjects is of great importance. As pointed out by Ayala (1970), it is not possible to completely avoid such language and terminology taking human intentions and purposes as a reference in the teaching of biological subjects. In this regard, as stated by Zohar and Ginossar

(1998) and Öztaş et al. (2005), it can be argued that the use of such anthropoformic terminology can enhance motivation and learning.

However, as revealed by many researchers, unconscious use of such language and terminology may distance learners from scientific thinking over time. Hence, it is critical to use anthropoformic terminology in such a way as not to prevent learners from making scientific and casual connections while learning natural events. Therefore, it is clear that alternative language and terminology complying with the nature of biology should be developed instead of language and terminology that can reduce biological events into mechanist process and distance learners from scientific thinking.

The present study was designed to reveal the general outlook of the Science and Technology pre-service teachers' tendencies to explain vitality. It seems to be necessary to carry out similar studies on different samplings in order to clarify the opinions of Science and Technology pre-service teachers who will have a great role in future generations' scientific learning of natural phenomena about the nature of vitality. In addition to this, there is a need to conduct research to determine the impacts of anthropoformic terminology particularly on the comprehension of vitality and on the comprehension of biological issues in general. In this respect, there is a need to conduct content analysis in Science and Biology curriculum in relation to its terminology. Moreover, the effects of anthropoformic terminology on the understanding of vitality should be investigated in relation to students' cultural characteristics, beliefs etc. Only in this way, it can be possible to understand the effects of anthropoformic thinking and language practices on science education in general and biology education in particular and this understanding can be effectively used in educational processes.

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